Reconstructing the lower urinary tract: The Mitrofanoff principle

Rajan Veeratterapillay, Helen Morton, Andrew C. Thorpe, Chris Harding

Department of Urology, Freeman Hospital, High Heaton, Newcastle Upon Tyne, NE77DN, United Kingdom

ABSTRACT

Since the original description of the trans-appendicular continent cystostomy by Mitrofanoff in 1980, a variety of techniques have been described for creating a continent catheterisable channel leading to the bladder, which avoids the native urethra. The Mitrofanoff principle involves the creation of a conduit going into a low pressure reservoir, which can emptied through clean intermittent catheterization through an easily accessible stoma. A variety of tissue segments have been used for creating the conduit, but the two popular options in current urological practice remain the appendix and Yang-Monti transverse ileal tube. The Mitrofanoff procedure has an early reoperation rate for bleeding, bowel obstruction, anastomotic leak or conduit breakdown of up to 8% and the most common long-term complication noted is stomal stenosis resulting in difficulty catheterizing the conduit. However, in both pediatric and adult setting, reports imply that the procedure is durable although it is associated with an overall re-operation rate of up to 32% in contemporary series. Initial reports of laparoscopic and robotic-assisted Mitrofanoff procedures are encouraging, but long-term outcomes are still awaited.

Key words: Appendix, Mitrofanoff, reconstruction

INTRODUCTION

The management of bladder dysfunction can be complex and patients can face numerous challenges and complications in the pursuit of continence.[1] Long-term urethral catheterization is associated with significant widely recognized problems such as catheter blockage, peri-catheter leak, urethral trauma/ strictures, and colonization by bacterial organisms.

The trans-appendicular continent cystostomy was first described by Mitrofanoff in 1980, using the appendix as a conduit between the bladder and skin.[2] This allowed the bladder to be emptied by a route other than the urethra and was a further revolutionary step in the field of urinary incontinence management following the earlier introduction of clean intermittent self-catheterization by Lapides.[3]

Since the original description by Mitrofanoff, numerous variations have been reported as the procedure has evolved, but the underlying principles of what has become known as a Mitrofanoff procedure are the creation of a conduit going into a low pressure reservoir, which can emptied through clean intermittent catheterization through an easily accessible stoma.[1,2] The indications for this procedure include refractory neurogenic bladder (with or without myelomeningocele), refractory idiopathic bladder dysfunction, severe urethral stricture disease as an adjunct to reconstruction in congenital urogenital abnormalities (cloacal exstrophy, posterior urethral valves, epispadias, and prune belly syndrome).

Advances in surgical technique have seen the development of both laparoscopic and robotic Mitrofanoff procedures.[4,5] In addition, long-term outcomes of the procedure have recently been described in the literature. The aims of this article are to revisit the surgical principles laid down by Mitrofanoff, to examine the technical modifications over the past three decades and to report the long-term outcomes.

TISSUE SEGMENTS FOR CONDUIT CONSTRUCTION

Mitrofanoff used a conduit made of appendix to give access to the bladder, but different gastrointestinal and

For correspondence: Mr. Rajan Veeratterapillay, Department of Urology, Freeman Hospital, High Heaton, Newcastle Upon Tyne, NE77DN, United Kingdom. E-mail: rajan.veeratterapillay@nuth.nhs.uk
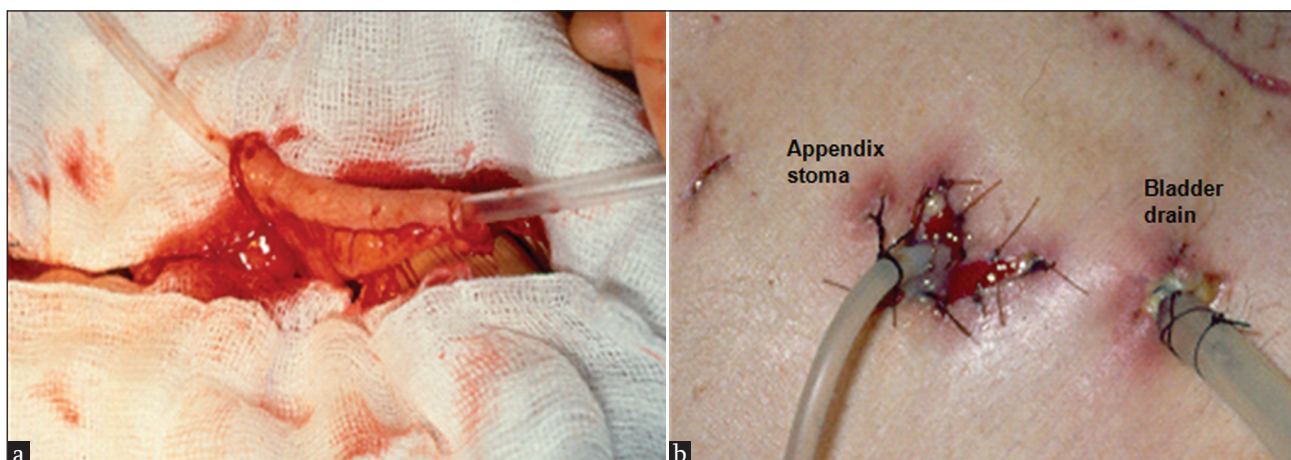
Figure 1: (a) Catheter passed through appendix to check patency, (b) Appendix stoma on skin with catheter *in situ*

urothelial segments have been employed for creation of a catheterizable conduit including cecum, small bowel, stomach, ureter, and bladder.[1] Currently, the appendix remains the conduit of choice where available and the most common second option is the transverse ileal (Yang-Monti) tube.

Appendix

Traditionally, a lower midline or Pfannenstiel incision is performed to allow access to the bladder and ileo-cecal junction and appendix.[2] The appendix is identified and disconnected from the cecum whilst preserving its mesentery. After passing a 14 Fr catheter down the isolated appendix [Figure 1] to check its patency, the end going into the bladder is usually tunneled submucosally for 3-4 cm into the bladder to achieve an anti-reflux effect. The appendix is then secured with absorbable sutures to the bladder muscle and mucosa. Different techniques exist for creating the anti-reflux mechanism depending on the type of conduit used (see section below).

Transverse ileal (Yang-Monti) tube

The Yang submucosal needle technique was first described in 1993 to reimplant ureters and to create a catheterisable ileal conduit following cystectomy in seven patients.[6] Following on from that, Monti *et al.* (1997) described the transversal tubularization of small segments of ileum in the canine model to create a catheterizable conduit.[7] These descriptions have formed the basis for the 'Yang-Monti' tube. In essence, this involves the isolation of a 2-3 cm ileal segment, which is detubularized. This is then retubularized transversely over a 14-18Fr catheter. One end of the 'Yang-Monti' tube is tunneled submucosally and sutured into the bladder whilst the other is brought to the abdominal wall as a stoma. In another technique when using a single ileal tube, one end can be imbricated and sutured into the reservoir and the other end brought out to the skin as a stoma.[8] Where a longer conduit is required, a double 'Yang-Monti' tube can be fashioned using two adjacent ileal

segments which are separately detubularized and attached to each other transversely.[1,7]

Other gastrointestinal segments - cecum and stomach

Some authors have reported the use of cecum where the appendix alone is too short to create a conduit.[9] This involves mobilization of the appendix and the base of the cecum. A stapling device is used to transect part of the cecum and the cecal base, along with the appendix, is detubularized to create the conduit. The cecal end is implanted into the bladder. If bowel is unavailable, a gastric segment can be harvested and tubularized as reported in a cohort of 10 adult and pediatric patients with a median follow-up of 3.5 years by Close and Mitchell.[10] Whilst good continence rates were noted, there is a higher incidence of conduit complications at the skin level due to gastric acid irritation.

Ureter, bladder and fallopian tube segments

The ureter remains a good catheterizable channel and was indeed used partly in Mitrofanoff's initial report. However, complication rates are noted to be higher. In a series of 22 patients using ureter as conduit, a 40% major complication rate was noted (including urine leak and need for complete revision).[11] In a further study looking at 60 conduits made with appendix or ureter, a higher stenosis rate was noted in patients where ureter was used.[12] Tubularized bladder flaps have also been described where a flap of full-thickness detrusor muscle is created and the tubularized over a 12 Fr catheter. Cain *et al.* reported 31 patients undergoing continent catheterizable vesicostomy who had a high stenosis rate (60%) but an excellent continence rate (100%).[13] Owing to the high stoma complication rates, ureter and bladder catheterizable conduits are less popular nowadays but remain an option in a large capacity bladder or where a redundant megaureter is available.

Some earlier reports following Mitrofanoff's original description suggested using fallopian tube as conduit, but this has not proved popular in contemporary practice

especially with concerns regarding future reproductive function and high stenosis rates.[5,14]

TECHNIQUES FOR ATTACHING THE CONDUIT TO THE RESERVOIR

Mitrofanoff underlined the importance of creating an anti-reflux submucosal tunnel where the appendix joined the bladder.[2] Depending on the tissue segment used for the conduit, a number of different techniques are available for creating the submucosal tunnel and they are generally based on the principles of ureteric re-implantation. Where ureter is used for the conduit, the technique described by Le Duc can be employed. This consists of the construction of an ileal sheet in which the ureter is implanted and introduced into the lumen of the reservoir via a transmural non-refluxing channel and left unfixed intraluminally.[8] In the modified technique, the distal ureteric end is widely spatulated, forming a ureteric plate, and directly adapted to the ileal mucosa. Another antireflux implantation technique is the nipple ureteric implantation with a split cuff described by Sagalowsky. The ureter is spatulated approximately 1 cm and folded back to form a split-cuff nipple. The corners are sewn to each other except for a small gap proximally to prevent constriction.[15] When an ileal segment is used as catheterizable conduit, the Kock nipple anti-reflux technique can be performed. This uses an ileal segment as an anti-reflux mechanism to create an intussuscepted ileal valve.[16] To fix the valve, four rows of staples affixed within the leaves of the valve and on the back wall outside the reservoir are used. A simpler form of an anti-reflux mechanism can be obtained by placing the ureter or ileal segment directly into serous-lined extramural tunnels.[17]

FASHIONING OF THE STOMA AT SKIN LEVEL

Generally speaking, the conduit is attached to the abdominal wall and a stoma is fashioned. The site should be easily accessible by the patient. The most common stoma sites described for the Mitrofanoff procedure have been the umbilicus and lower abdomen.[1,2] Four main techniques for stoma formation have been described in the literature including direct anastomosis, umbilical stoma, tubular skin flap (TSF) and the V-quadrilateral-Z (VQZ) flap technique. Perhaps the simplest technique for stoma formation is direct anastomosis of the intestinal conduit to the skin.[12] The main problems with this technique include an exposed conduit mucosa, increasing the chance of infection, and bleeding following catheterization. An umbilical stoma is created by detaching the umbilicus from the rectus sheath and attaching the conduit to its posterior end after spatulation.[12] In the TSF technique, a 3 cm skin flap is created in the lower abdomen and tubularized with the skin surface comprising the inner lining of the

conduit. The skin conduit is tunneled though the rectus muscle and an end to end anastomosis is performed to the intestinal conduit.[18] The VQZ technique for stoma creation involves the creation of a V-flap, which is sutured to the spatulated intestinal conduit.[19] A recent study looked at the complication with the three main techniques (umbilical stoma, TSF and VQZ). This involved 40 patients undergoing Mitrofanoff procedures where umbilicus was used for 31 conduits, the VQZ was used for 8 and the TSF was used for 11. The revision or dilatation rates for stomal stenosis were 45% for TSF, 25% for umbilical and 0% for VQZ flaps.[20] In addition, the decision on placement of the abdominal wall stoma may be made difficult by previous abdominal surgery or obesity. In obese patients, the umbilicus may be a good site to externalize a catheterizable channel as the abdominal wall width is thinnest at that point. In patients with previous abdominal surgery, the stoma should be sited away from abdominal scars to reduce the risk of ischemia.[18,19]

BLADDER AND BLADDER OUTLET CONSIDERATIONS

The bladder should be a good capacity, low pressure reservoir for a successful Mitrofanoff procedure. Sometimes, concomitant augmentation cystoplasty has to be performed; for instance, where preoperative urodynamics have confirmed a small bladder volume or loss of compliance with end-filling pressures more than 40 cm H_2O. Hence, situations where concomitant bladder augmentation would be required at the time of a Mitrofanoff procedure include congenital bladder anomalies (bladder exstrophy, epispadias, and posterior urethral valves with small capacity bladder), small capacity/poorly compliant bladder from neurogenic disease or post radiotherapy and inflammatory bladder disorders. The site of conduit implantation into the bladder has been investigated in a number of studies. In a recent study, anterior and posterior conduit implantation were compared in a cohort of 54 patients.[21] The results showed that although the rates of stomal complications were similar between the two groups, patients with anterior conduits and an increased risk of urinary tract infection and bladder stone formation. The authors postulated that patients with anteriorly implanted conduits may have suboptimal drainage.[21] In cases of augmentation cystoplasty, the catheterizable conduit can be implanted into the native bladder or the augmented patch. Continence and revision rates appear similar although one study suggested that the best combination was an appendix conduit implanted into a colonic augmentation segment.[22] The authors in that study describe a continence rate of 88% at 24 months follow-up and a revision rate of less than 20%.

The bladder outlet needs to be addressed if continence is not reached with a large capacity and compliant bladder. Bladder outlet enhancing procedures include endoscopic injection of bulking agents, bladder neck reconstructions,

and extrinsic compression of the bladder neck/urethra using slings, the artificial urinary sphincter, and bladder neck closure. When multiple bladder neck surgeries fail, bladder neck closure is often performed as the final intervention to achieve dryness, but is an irreversible procedure requiring compliance with catheterization of a cutaneous stoma. Historically, it has been reserved for the definitive treatment of intractable incontinence after prior failed procedures.[23]

SHORT- AND LONG-TERM SURGICAL OUTCOMES

The creation of a Mitrofanoff channel is a major abdominal procedure and there is an early re-operation rate for bleeding, bowel obstruction, anastomotic leakage or breakdown of the conduit. The most common long-term complications noted in the literature are stenosis of the conduit, incontinence, and need for the surgical revision [Table 1].[1,24]

Early surgical complications

Early re-operation rate has been reported to be between 1.2% and 8%. In one recent study of 65 adult patients having Mitrofanoff procedures, Gowda *et al*. reported an 8% need to

return to theatre in the peri-opeartive period for bleeding, bowel obstruction or anastomotic leak.[25]

Stenosis of stoma or conduit

As regards long-term complications, stenosis of the conduit is reported in 0-100% of Mitrofanoff procedures and the incidence generally increased with the length of follow-up.[1,24,26] For instance, in studies where appendix or ileum had been used as conduit, stomal stenosis rates were 6% at a median follow-up of 28 months but rose to 54% at 126 months.[24,25]

In addition, higher stenosis rates and stomal complications are noted in patients with conduits fashioned out of ureter, bladder or gastric segments.[10-12] The majority of studies describe initial management of stomal or conduit stenosis by endoscopic dilatation, but some patients eventually require revision surgery. One of the longest follow-up studies of 28 patients by Sahadevan *et al*. reported a mean frequency of dilation of 0.4 (0.1-2.4) episodes per year but 32% of patients eventually required revision of the conduit.[24] One of the lowest conduit stenosis rates (2.4%) was reported by Sultan *et al*. who followed-up 82 pediatric patients who had appendix or ileal Mitrofanoff as part of

Table 1: Contemporary Mitrofanoff series

Study	No. of patients	Technique	Conduit	Reservoir	Stenosis %	Revision %	Early laparotomy for postop complications %	Incontinence %
Wille *et al*. BJUI, 01 2012	3	Robotic	Appendix	Native bladder	0	0	0	0
Wille *et al*. J of Urology, 04 2011	11	Robotic	Appendix	Augmented bladder	0	27.3	0	9.1
Gundeti *et al*. BJUI, 03 2011	5	Robotic	Appendix	Augmented bladder	0	60	0	0
Spahn *et al*. Urology, 05 2010	17	Open	Appendix Yang-Monti	Native and augmented	23.5	17.6	–	–
Kajbafzadeh *et al*. J of Urology, 03 2010	13	Open	Ureter	Uretero-cystoplasty	0	0	0	7.7
Nguyen *et al*. J of Urology, 10 2009	10	Robotic	Appendix	Native bladder	0	10	0	30
Van der Aa *et al*. 2009	35	Open	Ileum	Native and augmented	–	28.6	–	–
Gowda *et al*. BJUI, 12 2008	65	Open	Appendix Ileum Ureter	Native and augmented	–	75.2	8	4.6
Sultan *et al*. J of Urology, 10 2008	82	Open	Appendix Ileum	Augmented bladder	2.4	0	1.2	3.7
Welk *et al*. J of Urology, 10 2008	67	Open	Appendix Ileum	Native and augmented	6.0	9.0	0	9.0
Sahadevan BJUI, 07 2008	28	Open	Appendix Ileum	Native and augmented	57	32.1	0	10.7
England and Subramaniam J of Urology, 12 2007	23	Open	Appendix Ileum	Native	21.7	8.7	0	7.1

reconstructive surgery following congenital abnormalities (posterior urethral valves, exstrophy, and neuropathic bladder).[27] The authors here attributed these good results with the use of the VQZ reconstruction at skin level and conduits made using appendix or ileum.

Some authors have compared the stenosis rates between an appendix and Yang-Monti conduit and results have been conflicting. In one study of 122 patients, stomal stenosis was noted to be less common with the Monti conduit (29%).[28] However, another report by Naranayaswamy *et al*. showed that the Monti conduit was more likely to stenose (60%).[29] A further study of 65 patients found no difference in stenosis rates between either conduit type.[30]

Revision rates following Mitrofanoff

In cases of stomal stenosis or incontinence following an initial Mitrofanoff procedure, revision of the conduit or reservoir (e.g., further augmentation) is required. Some patients even require urinary diversion surgery. The revision rate in the literature is between 0% and 75%, again increasing with the length of follow-up. Some of the early studies reporting no revision surgery had follow-up time of less than 15 months.[30] In contemporary series, overall revision rates have ranged from 8.7% to 32%.[24,31,32,33]

At a mean follow-up of 75 months, Gowda *et al*. reported that following revision surgery, 92% of patients still had a Mitrofanoff conduit, of which 97% are catheterizable and 95% are continent.[25] In the series by Sahadevan *et al*., 82% of patients still had a catheterizable Mitrofanoff conduit at 126 months.[24]

Continence rates

In pediatric series, continence rates following Mitrofanoff procedures have been reported to be between 79% and 100%. Duckett and Lotfi reported a 100% continence rate in 41 patients after a mean follow-up of 3.2 years.[34] Liard *et al*. had one of the longest average follow-up time of 20 years and reported a continence rate of 79% in 23 patients.[35] In the adult population, similar continence rates of up to 96% have been reported. In a large cohort of 419 patients with ileo-cecal reservoirs, a 91% continence rate was noted at 2.5 years.[36] More recently, Gowda *et al*. reported similar continence rates of 96% in a cohort of 65 patients.[25] Piaggio *et al*. studied the influence of type of conduit (appendix versus Yang Monti) and site of implantation (augmentation versus native bladder) and found no difference in the continence rate between either approach (90% initial continence rate).[37]

Bladder calculi and urinary tract infection (UTI)

The incidence of UTIs has not been widely reported in many of the follow-up studies. Apart from the risk factors such as the use of clean intermittent self catheterization and intestinal augmentation, compliance has been reported to be one of the pre-disposing factors for UTI.[22] Patients who do not empty their bladder regularly seem to have a higher incidence of UTI.[36] Inability to completely empty the reservoir can also lead to bladder calculus formation. Liard *et al*. showed a 22% incidence of bladder calculi at a mean follow-up time of 20 years, but a recent contemporary report by Sultan *et al*. reported on a lower rate of 4%.[27,35] Barroso *et al*. also reported that there was a slightly increased incidence of calculi following Mitrofanoff procedures, but noted that there was no significant difference between those who had an augmented bladder or a native bladder.[38] It has been postulated that a further mechanism for UTI and bladder calculi formation is that the transposed intestinal segments continue to secrete mucin.[39]

MINIMALLY INVASIVE SURGERY

Recent reports have confirmed the technical efficacy of laparoscopic and robotic-assisted Mitrofanoff procedures. [4,5] For these studies, short term results are encouraging but longer follow-up reports are required to see if they match the previously reported outcomes.

CONCLUSION

Continent urinary diversion, based on the Mitrofanoff principle, has similar outcomes in adult urological practice to those described in published pediatric case series. There is good evidence to suggest that Mitrofanoff conduits are durable, but there is a high need for re-intervention especially for stomal stenosis. However, patients should be aware of complications and the need for long-term follow-up.

REFERENCES

1. Farrugia MK, Malone PS. Educational article: The Mitrofanoff procedure. J Pediatr Urol 2010;6:330-7.
2. Mitrofanoff P. Trans-appendicular continent cystostomy in the management of the neurogenic bladder. Chir Pediatr 1980;21:297-305.
3. Lapides J, Diokno AC, Silber SJ, Lowe BS. Clean, intermittent self-catheterization in the treatment of urinary tract disease. J Urol 1972;107:458-61.
4. Hsu TH, Shortliffe LD. Laparoscopic Mitrofanoff appendicovesicostomy. Urology 2004;64:802-4.
5. Barroso U Jr, Duel B, Barthold JS, González R. Orthotopic urethral substitution in female patients using the mitrofanoff principle. J Urol 1999;161:251-3.
6. Yang WH. Yang needle tunneling technique in creating antireflux and continent mechanisms. J Urol 1993;150:830-4.
7. Monti PR, Lara RC, Dutra MA, de Carvalho JR. New techniques for construction of efferent conduits based on the Mitrofanoff principle. Urology 1997;49:112-5.
8. Kato H, Igawa Y, Ogawa A. Incontinent ileal tube repaired by infolding with the ileal pouch wall. Int J Urol 1997;4:428-30.
9. Bruce RG, McRoberts JW. Cecoappendicovesicostomy: Conduit-lengthening technique for use in continent urinary reconstruction. Urology 1998;52:702-4.

10. Close CE, Mitchell ME. Continent gastric tube: New techniques and long-term followup. J Urol 1997;157:51-5.

11. Mor Y, Kajbafzadeh AM, German K, Mouriquand PD, Duffy PG, Ransley PG. The role of ureter in the creation of Mitrofanoff channels in children. J Urol 1997;157:635-7.

12. Van Savage JG, Khoury AE, McLorie GA, Churchill BM. Outcome analysis of Mitrofanoff principle applications using appendix and ureter to umbilical and lower quadrant stomal sites. J Urol 1996;156:1794-7.

13. Cain MP, Rink RC, Yerkes EB, Kaefer M, Casale AJ. Long-term followup and outcome of continent catheterizable vesicocstomy using the Rink modification. J Urol 2002;168:2583-5.

14. Furness PD, Malone PS, Barqawi Al B, Koyle M. The Mitrofanoff principle. Innovative applications in continent urinary diversion. Contemp Urol 2003 15(1):30-45.

15. Sagalowsky AI. Early results with split-cuff nipple ureteral reimplants in urinary diversion. J Urol 1995;154:2028-31.

16. Kock NG, Nilson AE, Nilsson LO, Norlén LJ, Philipson BM. Urinary diversion via a continent ileal reservoir: Clinical results in 12 patients. J Urol 1982;128:469-75.

17. Abol-Enein H, Ghoneim MA. Functional results of orthotopic ileal neobladder with serous-lined extramural ureteral reimplantation: Experience with 450 patients. J Urol 2001;165:1427-32.

18. Woodhouse CR. Continent Urinary Diversion. London: Churchill Livingstone; 2002.

19. Murthi GV, Kelly JH. V-V plasty: A new technique for providing a resilient skin-lined opening for the Mitrofanoff stoma. Urology 2006;68:661-2.

20. Landau EH, Gofrit ON, Cipele H, Hardak B, Duvdevani M, Pode D, *et al*. Superiority of the VQZ over the tubularized skin flap and the umbilicus for continent abdominal stoma in children. J Urol 2008;180:1761-5.

21. Berkowitz J, North AC, Tripp R, Gearhart JP, Lakshmanan Y. Mitrofanoff continent catheterizable conduits: Top down or bottom up? J Pediatr Urol 2009;5:122-5.

22. Franc-Guimond J, González R. Effectiveness of implanting catheterizable channels into intestinal segments. J Pediatr Urol 2006;2:31-3.

23. Kavanagh A, Afshar K, Scott H, MacNeily AE. Bladder neck closure in conjunction with enterocystoplasty and Mitrofanoff diversion for complex incontinence: Closing the door for good. J Urol 2012;188:1561-5.

24. Sahadevan K, Pickard RS, Neal DE, Hasan TS. Is continent diversion using the Mitrofanoff principle a viable long-term option for adults requiring bladder replacement? BJU Int 2008;102:236-40.

25. Gowda BD, Agrawal V, Harrison SC. The continent, catheterizable abdominal conduit in adult urological practice. BJU Int 2008;102:1688-92.

26. Welk BK, Afshar K, Rapoport D, MacNeily AE. Complications of the catheterizable channel following continent urinary diversion: Their nature and timing. J Urol 2008;180:1856-60.

27. Sultan S, Hussain I, Ahmed B, Aba Umer S, Saulat S, Naqvi SA, *et al*. Clean intermittent catheterization in children through a continent catheterizable channel: A developing country experience. J Urol 2008;180:1852-5.

28. McAndrew HF, Malone PS. Continent catheterizable conduits: Which stoma, which conduit and which reservoir? BJU Int 2002;89:86-9.

29. Narayanaswamy B, Wilcox DT, Cuckow PM, Duffy PG, Ransley PG. The Yang-Monti ileovesicostomy: A problematic channel? BJU Int 2001;87:861-5.

30. Lemelle JL, Simo AK, Schmitt M. Comparative study of the Yang-Monti channel and appendix for continent diversion in the Mitrofanoff and Malone principles. J Urol 2004;172:1907-10.

31. Wille MA, Zagaja GP, Shalhav AL, Gundeti MS. Continence outcomes in patients undergoing robotic assisted laparoscopic Mitrofanoff appendicovesicostomy. J Urol 2011;185:1438-43.

32. England RJ, Subramaniam R. Functional and cosmetic outcome of the VQ plasty for Mitrofanoff stomas. J Urol 2007;178:2607-10.

33. Spahn M, Kocot A, Loeser A, Kneitz B, Riedmiller H. Last resort in devastated bladder outlet: Bladder neck closure and continent vesicostomy – Long-term results and comparison of different techniques. Urology 2010;75:1185-92.

34. Duckett JW, Lotfi AH. Appendicovesicostomy (and variations) in bladder reconstruction. J Urol 1993;149:567-9.

35. Liard A, Séguier-Lipszyc E, Mathiot A, Mitrofanoff P. The Mitrofanoff procedure: 20 years later. J Urol 2001;165:2394-8.

36. Wiesner C, Bonfig R, Stein R, Gerharz EW, Pahernik S, Riedmiller H, *et al*. Continent cutaneous urinary diversion: Long-term follow-up of more than 800 patients with ileocecal reservoirs. World J Urol 2006;24:315-8.

37. Piaggio L, Myers S, Figueroa TE, Barthold JS, González R. Influence of type of conduit and site of implantation on the outcome of continent catheterizable channels. J Pediatr Urol 2007;3:230-4.

38. Barroso U, Jednak R, Fleming P, Barthold JS, González R. Bladder calculi in children who perform clean intermittent catheterization. BJU Int 2000;85:879-84.

39. Keegan SJ, Graham C, Neal DE, Blum-Oehler G, N'Dow J, Pearson JP, *et al*. Characterization of Escherichia coli strains causing urinary tract infections in patients with transposed intestinal segments. J Urol 2003;169:2382-7.